CEMENTITIOUS EXTERIOR SHEATHING PRODUCT HAVING IMPROVED INTERLAMINAR BOND STRENGTH

CROSS REFERENCE TO RELATED APPLICATION

The present application is a Division of U.S. application Ser. No. 11/564,517, filed Nov. 29, 2006, which is a Division of U.S. application Ser. No. 10/342,529, filed Jan. 15, 2003 (D0932-00291), now U.S. Pat. No. 7,155,866, which is a continuation-in-part of U.S. application Ser. No. 10/288,189, filed Nov. 5, 2002, now U.S. Pat. No. 7,028,436 (D0932-00276).

FIELD OF THE INVENTION

This invention relates to exterior sheathing products which incorporate cementitious materials, and especially, fibercement sheathing having greater interlaminar bond strength.

BACKGROUND OF THE INVENTION

Fibercement has been used in the United States building materials industry since the 1980's. This material is used in residential and commercial construction applications as an alternative to wood for siding, roofing, backer board, trim and fascia applications. Fibercement is fire and insect resistant, and is more durable. In fact, it was the fastest growing market segment in the exterior sheathing industry in the 1990's, and by 2005, this material is expected to gain up to 25 percent of the siding market.

Fibercement is, technically, a composite of portland cement, aggregate (usually sand), and cellulose fibers. Cellulose fibers are added to cement to increase its toughness and crack-arresting ability. Fibercement shingle and shake products are widely available from such sources as James Hardie, Inc. under the brand name Hardiplank® and CertainTeed Corporation under the brand name Weatherboards™. These products are produced by the Hatchek de-watering process, which results in a laminated flat sheet reinforced with a significant amount of cellulose fibers, usually about 30-35 percent by volume.

Fibercement materials possess useful properties, but they were at one point in their history believed to be unsuitable for exterior use since they were susceptible to damage due to the effect of freeze-thaw cycles. See Harper et al., U.S. Pat. No. 4,637,860. Freeze-thaw action can cause severe deterioration to fibercement building products. The primary cause of damage is due to the hydraulic pressures that develop as water freezes and expands in tiny fissures and pores of cementitious materials. Once these forces exceed the strength of the material, cracking occurs. During subsequent thawing, the water then moves through the cracks, expanding them further, to cause more damage when freezing occurs again.

Harper et al., U.S. Pat. No. 4,637,860, suggested that better freeze-thaw resistance could be achieved by autoclaving a cellulose fibercement mixture with silica sand additions. These inventors also recognized that silica sand additions reduced the density of formed sheet materials to a level below that necessary to achieve sufficient strength and freeze-thaw resistance. Accordingly, the '860 patent suggested compressing the wet mixture in a press to reduce its thickness and increase its density prior to autoclaving. Such a process has been proven to be effective in increasing the interlaminar bond strength ("ILB strength") of fibercement boards when pressures approaching 30 bar are used. See Wierman et al., "The Effects of Pressure on Freeze-Thaw Durability of Fiber-Reinforced Cement Board" (September, 2002).

While improvements to the processing of fibercement sheathing have been introduced, there have been some notable disadvantages associated with fibercement products compared to vinyl siding products. Specifically, even with cellulose fiber reinforcement, fibercement exterior panels are susceptible to cracking by nails and screws, especially along their edges. Moreover, while high pressure pressing has improved ILB strength, fibercement trim boards are still susceptible to freeze-thaw delamination failures, and could be improved in this area.

Accordingly, there is a current need in the cementitious exterior sheathing industry for a more durable cementitious siding and trim panel.

SUMMARY OF THE INVENTION

This invention provides exterior building products which, in a first embodiment, include an exterior-facing side having an aesthetic appearance, a wall-facing side, and a cross-sectional thickness. The building product further comprises a plurality of layers containing a cementitous mixture, including cement, reinforcing fibers and aggregate. It further contains a resinous bond promoter disposed at least within an interlaminar region defined by two of said layers in said building product to increase the interlaminar bond strength of said building product.

The present invention represents a significant improvement in ILB strength for cementitious building products, such as siding, shakes, roofing shingles, soffiting, and the like. By introducing a resinous bond promoter, such as acrylic, starch, polyvinyl alcohol, or polyvinyl acetate, a rheological agent, or by the use of mechanical means, such as a pin roll, vibration table, or needling machine for piercing or agitating the assembled sheet and displacing the fibers generally perpendicular to the plane of the sheet, thus allowing the fibers to join the sheets together, improved strength between individual layers of cementitious material can be attained. Sufficient resinous additions, manipulation of the fiber, or both, can result in improvements to ILB strength of at least about 10%, preferably about 25%, and most preferably in excess of 40%, with improvements in the percent elongation (a measure of ductility) of at least about 5%, preferably about 7%, and most preferably greater than 15%.

Such improvements in ILB strength and ductility have the potential of increasing the durability of such building products, and may allow lighter density or thinner products to be commercialized. When resinous bond promoters are employed, a further unexpected benefit has been obtained by a significant reduction in water absorption, measured in treated test samples. This testing clearly demonstrates that samples incorporating acrylic-based bond promoters between fibercement layers actually assist the product in resisting water penetration throughout the product thickness, even at its exterior face. Since the preferred bond promoter, acrylic emulsion, is similar to the sealer coater often used for exterior fibercement products, the sealer step in the production of fibercement products can be eliminated, along with its attendant drying and curing steps, to reduce manufacturing costs. In addition to these cost savings, the reduction in water penetration throughout the product limits the amount of water which can contribute to the freeze-thaw effect, and